Meeting
May 23, 1960

MEETING AT THE ROYAL COLLEGE OF SURGEONS, LINCOLN'S INN FIELDS, LONDON

Ivory

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MOST dental or odontological museums contain considerable quantities of ivory and the Odontological Museum of the Royal College of Surgeons is certainly no exception. At a very rough estimate the total quantity of ivory in the collection must weigh at least a ton.

Chronologically it is appropriate to mention first a specimen in which we take great pride (Fig. 1). It is certainly the oldest specimen in the collection and is of topical interest because this is the year of the Tercentenary of the Royal Society. The specimen originally belonged to the Royal Society and was described by Grew (1681) in the following terms:

"A spiral or wreathed tusk of an elephant. Presented from the Royal African Company by Thomas Crispe, Esq. It is twisted and wreathed from the bottom to the top with three circumvolutions standing between two straight lines. 'Tis also furrowed by the length. Yet the furrows surround it not as in the horn of the Sea Unicorn, but run parallel therewith. Neither is it round as the said horn, but somewhat flat. The tip very blunt."

In 1781, at the time the Royal Society was moving to new premises in Somerset House, the Society transferred its collection of rarities to the British Museum, then only in its infancy (Lyons, 1944). In 1809 the British Museum disposed of a number of anatomical preparations to the Royal College of Surgeons for the sum of £175 10s. and some of the original Royal Society

FIG. 1.—"Royal Society" spiral tusk. (Odontological Series G. 122.8.)

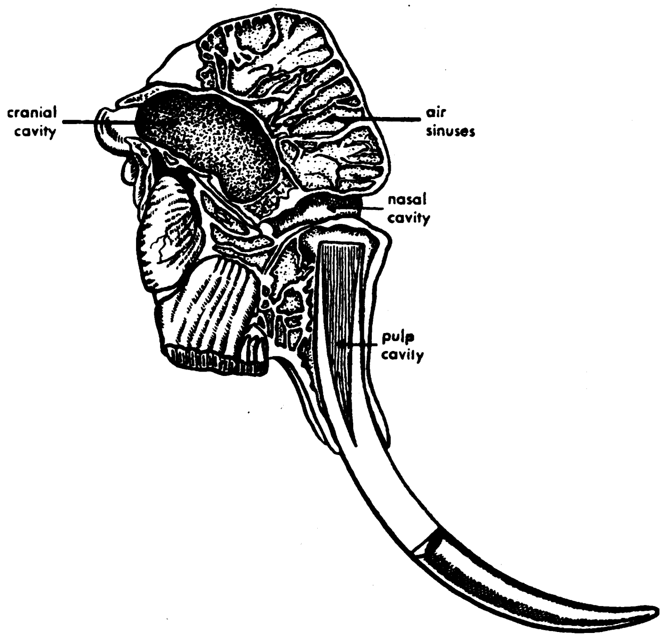

FIG. 2.—Longitudinal section through skull and part of tusk of an Indian elephant. After Owen (Odontography, Pl.146).

specimens were included in the sale (Cope, 1959). Among them was this tusk which thus became part of the Odontological Collection of the Museums of the Royal College of Surgeons.

One of the reasons why elephant ivory and elephant tusks form such a common feature in odontological museums is that they present examples of dental lesions, especially of the dental pulp, on a gigantic scale. The pulp in the tusk shows a quite remarkable ability to recover after severe injury. This recuperative power is attributable at least partly to the enormous size of the pulp and to the fact that, as the tusk is of continuous growth, the pulp has a good blood supply through the wide funnel-shaped base of the root (Fig. 2).

It is not, of course, possible to examine the pulp itself in these museum specimens; nevertheless the probable sequence and nature of events can often be deduced from a study of the shape and structure of the hard parts (Colyer, 1926; Colyer and Miles, 1957).

The tusk seems to be liable to two principal kinds of injury. Firstly, breaking off of the tusk, perhaps during combat or in falls—sometimes no doubt falls into concealed pits made to entrap the animals. When the tusk is broken off the pulp may become exposed because in some cases the living pulp extends into the erupted part of the tusk. There is in our Collection quite a number of examples where, although the exposed part of the pulp must have died and abscesses may have arisen in connexion with the remainder, the pulp has survived to go on forming the tusk which, although deformed, has continued to function. It is very interesting that in many such specimens there is a tendency for longitudinal

FIG. 3A.—Fractured tusk of elephant. The distal extremity (below) presents a worn fractured surface. The greater part of the specimen was formed after the injury and shows the formation of separate elements. (Odontological Series G. 132.4.)

FIG. 3B.—Part of transverse cut surface near the middle of specimen showing disorganisation of growth with formation of separate "columns" of tissue. (Odontological Series G. 132.4.)

splitting or folding of the pulp to occur to form partially, or even entirely, separate small tusks. A typical specimen is shown in Fig. 3A. The distal end of the tusk presents a worn fractured surface and a zone of interrupted growth shows that the greater part of the specimen was formed after the tusk was fractured. The outer surface of this part of the tusk shows longitudinal grooving which becomes progressively deeper towards the proximal end and which at the time of death and removal of the tusk had led to the emergence of at least two entirely separate growing elements. A transverse section (Fig. 3B) from near the middle of the specimen shows that the internal structure is split up into a number of columns. It is of interest that, although the growth of the tusk has been considerably disorganized by the injury, the lozenge pattern characteristic of elephant ivory is clearly discernible.

Another specimen in the Collection, of similar character but in which the interval between the time of the fracture and death of the animal was known to be two years, provided an opportunity to calculate the rate of growth of the tusk (Colyer and Miles, 1957). The calculated growth rate was 3·3 mm per week which corresponds closely with that of the continuously growing incisors of other animals such as the porcupine and rabbit.

The second type of injury to which tusks are liable is from bullets or musket balls or from spears. Early writers were sometimes puzzled to find musket balls within the solid ivory without there being any evidence of a point of entry; they were particularly intrigued if the ball of soft lead showed no sign of flattening from impact with the hard ivory. The presence of a number of such specimens in the Hunterian Collection shows that this is a condition that attracted the attention of John Hunter.

The explanation of a bullet in the substance of the ivory with no obvious point of entry is, of course, that the bullet penetrated into the dental pulp, above the level of the growing end of the tusk, perhaps from a shot from slightly above or aimed at an animal with head lowered to charge.

Fig. 4 shows a specimen in which the musket ball is lying loosely in a cavity. The irregular or "reactionary dentine" formed in response to the injury is known to dealers and workers in ivory as "pith". The outer layer of cementum, which may be very thick, is known as the "bark".

FIG. 4.—Transverse section through a tusk showing repair of the tissue with irregular reactionary dentine (B) following injury by a bullet which lies loosely in a cavity (A).

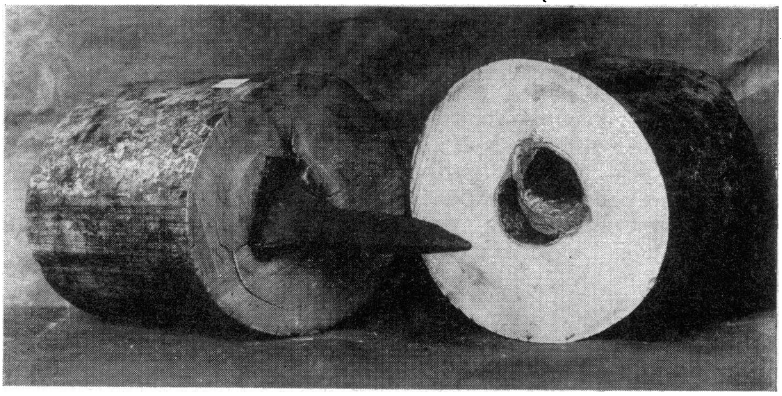

FIG. 5.—Spearhead 7½ in long lying free in the pulp cavity of a tusk. (Odontological series G. 126.1.)

Fig. 5 shows a very remarkable specimen described by Sir John Bland-Sutton (1910). It is a part of a tusk in the pulp cavity of which the iron head of a spear is lying. This must have entered the open developing end of the tusk from above and almost certainly is part of a weighted spear dropped from a tree. The hunter lies in wait on a branch overhanging a waterhole where elephants are likely to come to drink and if an elephant moves into a favourable position the weighted spear is dropped (Fig. 6). A study of Fig. 2 shows how the spear could enter the funnel-shaped end of the tusk.

One of the most attractive and mysterious features of elephant ivory is that a surface cut transverse to the axis of the tusk shows a geometrically regular pattern (Fig. 7). An analysis of the pattern shows that it is composed of two systems of radiating curved lines which begin at the centre of the tusk and sweep outwards in smooth curves to the periphery. One set of lines curves clockwise and the other anti-clockwise. The two systems of lines inter-cross in a regular fashion and divide up the surface into diamond or lozenge-shaped areas which become progressively smaller towards the centre of the tusk. In addition there are the less evident concentric growth lines or lines of Owen.

This lozenge pattern is a constant feature of elephant tusk ivory and is not present in the ivory of the tusk of hippopotamus, walrus, narwhal or wild boar.

Although described by Retzius (1837) and illustrated by Owen (1845) this peculiarity of elephant ivory does not appear to have been satisfactorily explained. A study which will be reported in full elsewhere (Miles and Boyde) suggests that the pattern depends upon the fact that in a longitudinal section cut radially to the

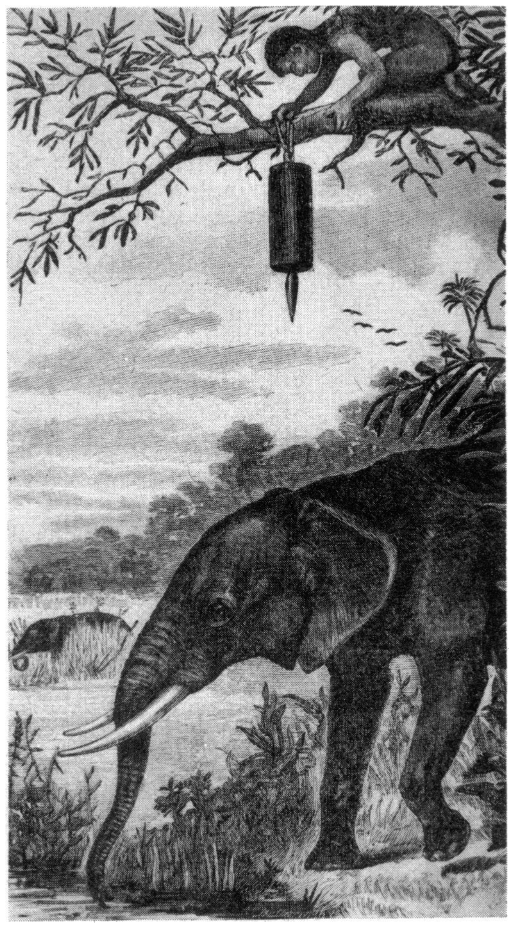

FIG. 6.—A sketch illustrating a method by which African natives attempt to kill elephants. A heavily loaded spear is dropped upon the animal when visiting a drinking pool. Reproduced from Bland-Sutton (1910) by kind permission of the Editor of the *Lancet*.

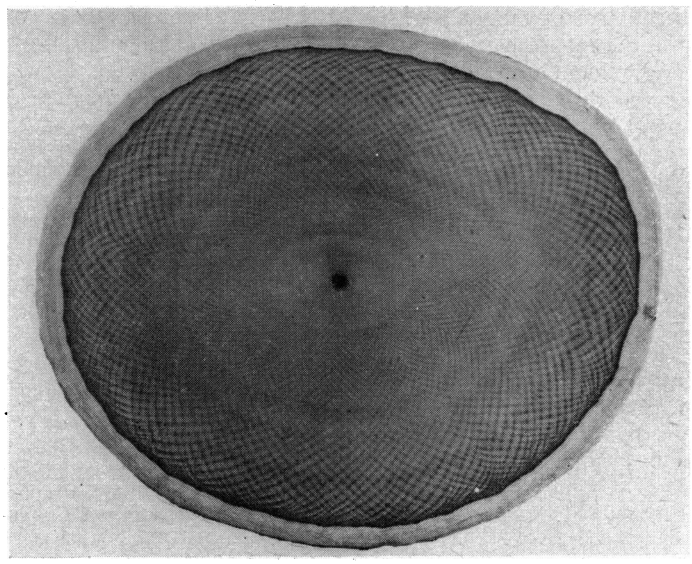

Fig. 7.—Transverse polished surface through the tusk of an African elephant.

centre of the tusk the tubules pass in regular sinuous curves across the thickness of the ivory. Sections in other planes, especially longitudinal ones tangential to the centre of the tusk, show that the tubules are arranged in groups or segmental columns within which the curvatures of tubules are all in the same phase but are in the reverse phase from those of the adjacent columns, that is the troughs of the waves of one column are opposite the crests of the waves in the next (Fig. 8). It seems that ivory appears light or dark according to whether the rays of light strike convexities or concavities of the groups of curved tubules. Were such an arrangement to exist in a tissue which was not circular in section, but where the pulpal surface was quite flat so that the tubules passed across the dentine parallel to one another and were not radiating from curved surfaces, a pattern of rows of alternating light and dark spaces like a chequer board would be produced. As in a chequer board diagonals would be a feature of the design. If the chequer board was made of rubber and was bent round, the diagonals would become curved and the squares distorted in shape; in fact the pattern would basically be the same as that seen in cross-sections of the tusk.

This lozenge pattern enables elephant ivory to be identified in ivory carvings, billiard balls, knife handles, piano keys and all the variety of articles for which ivory is employed. Until the advent of vulcanite about the middle of the last century ivory was, apart from precious metals, the usual material from which dentures were

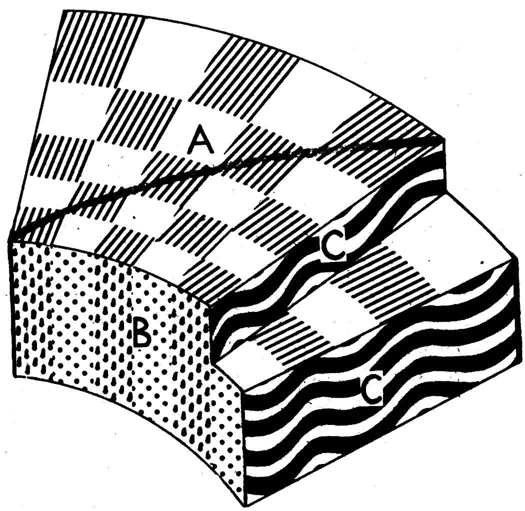

FIG. 8.—Diagrammatic representation of a part of a cross-section of tusk showing the arrangement of tubules in "segmental columns" responsible for the chequered appearance of the surface A. A line drawn through the dark areas emphasises the curved nature of the diagonals. B indicates the pulpal surfaces of the "segmental columns" or groups of tubules. Part of a "column" has been removed to show the undulating curvatures of the tubules in radial sections (C). Troughs of the curves in one "column" are opposite the crests in the adjacent "column".

made. Probably because of its relative softness and less durability in the mouth ivory from the elephant was, however, seldom used for dentures, as is evidenced by the rarity with which the lozenge pattern is found on these articles. Hippopotamus and walrus ivory were the most favoured materials for this purpose, walrus ivory being regarded as a more easily worked and cheaper substitute. According to Spence-Bate (1860) the market prices of hippopotamus and walrus ivory at about that time were respectively 12–30 shillings and 3–8 shillings per pound.

It may well be that the dealings between the ivory-carving dentist of those days and the ivory dealers, who from time to time discovered, no doubt with chagrin, musket balls embedded in the ivory, provided the channel through which so many specimens of that kind found their way into odontological museums.

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